Getting fish moving:
Promoting effective fish passage management in NZ
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Outline

• What is fish passage & why does it matter?
• Introduction to the NZ Fish Passage Guidelines
  • New structures
  • Existing structures
• Putting it in to practice
• Introduction to the NZ Fish Passage Assessment Protocol
• Q&A session
What is fish passage & why does it matter?
What is fish passage?

The “promotion of healthy aquatic ecosystems through restoration or maintenance of ecological connectivity”

(Silva et al. 2018)


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Why does it matter?
Why does it matter?

• Structures such as culverts, weirs and dams can limit or block migrations
• When fish can’t access critical habitats their populations decline

BUT...
• Barriers can also protect threatened species & prevent spread of exotic species
Why does it matter?

- Freshwater Fisheries Regulations 1983
  - Culverts & fords **may not be built** in such a way as to **impede fish passage** without a permit from DOC
  - Culverts & fords **must be maintained** to **prevent** the development of **fish passage barriers** unless removed or exempted
  - DOC may **require** that any **dam or diversion structure** has a **fish facility** included & set conditions on their design & performance
Why does it matter?

• Resource Management Act 1991
  – s.13 refers to **avoiding**:  
  – damaging, destroying, disturbing, or **removing** the **habitats** of animals; or 
  – using, **erecting, reconstructing, placing, altering, extending**, removing or demolishing any **structure**
    
    ...in, on, or under the bed of a lake or river

• National Policy Statement for Freshwater Management 2017
  – Ecosystem health as compulsory national value
Introduction to the new NZ Fish Passage Guidelines
Rationale

• Provide access to information needed to design for fish passage
• Set minimum design standards
• Enable more consistent fish passage management across NZ
• Basis for shifting expectations
Scope

• Structures ≤4 m high
• Design of new structures
• Remediation of existing structures
• Creation of built barriers
• Monitoring
Objectives

Good fish passage design will achieve:

• Efficient and safe upstream and downstream passage of all aquatic organisms and life stages with minimal delay or injury
• The structure provides no greater impediment to fish movements than adjacent stream reaches
• A diversity of physical and hydraulic conditions leading to a high diversity of passage opportunities
• Continuity of geomorphic processes such as the movement of sediment and debris
• Structures have minimal maintenance requirements and are durable
Principles of good fish passage design

The principles of good fish passage design include:

• Maintaining continuity of instream habitat
• Minimising alterations to stream alignment
• Minimising alterations to stream gradient
• Maintaining water velocities within a range equivalent to adjacent stream reaches
• Maintaining water depths within a range equivalent to adjacent stream reaches
• Minimising constraints on bankfull channel capacity
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• Maintaining water depths within a range equivalent to adjacent stream reaches
• Minimising constraints on bankfull channel capacity
• Avoiding vertical drops
• Providing an uninterrupted pathway along the bed of the structure
Design of new structures
Guidance for new structures

Don’t build new barriers!
Minimum standards v best practice
Stream crossings

- Bridge:
  - Natural bed and banks
  - Natural water depths and velocities
  - Natural substrate
  - Preserves stream gradient and alignment
  - Minimal construction disturbance
  - ...

- Ford:
  - Artificial bed and banks
  - Reduced depth and increased velocity
  - Often creates a vertical barrier on the downstream face
Stream simulation culvert design

Culvert span ≥ 1.2 x bankfull width + 0.6 m

Banks inside culvert
Natural stream substrate inside culvert
Culvert invert embedded
Hydraulic culvert design

Culvert span ≥ 1.3 x bankfull width for streams with bankfull width < 3 m

Stable substrate inside culvert

Culvert invert embedded

Water velocity & depth match adjacent stream or fish requirements
Fords – Avoid them!

• Shallow, fast flows
• Downstream vertical face
• Undersized culverts
• Bed disturbance
Fords – if you have to...

- Avoid or minimise any reduction of the channel cross-sectional area at the ford
- Where multiple barrels are required, box culverts should be used to span the full wetted width of the stream without significantly constricting cross-sectional area.
- Substrate must be maintained through the full length of the culverts
- Avoid or minimise alteration of natural stream channel alignment & gradient.
- The ford surface should be roughened (e.g. through embedding rocks) to facilitate passage of fish over the ford when flows overtop the structure.
- The lateral profile of the ford should be V-shaped to ensure that wetted margins are maintained when it is overtopped during elevated flows.
Head control structures

Order of preference

Most

- Rock ramp fishway

- V-shaped broad-crested weir with baffled surface

Least

- Weir with bypass channel

Side

Front

Plan

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NIWA
Taheo Nukurangi
Rock-ramp weir design

- V-shaped lateral profile
- Gentle slope (1:30)
- Low velocity wetted margins
Conventional weir design
Dealing with existing structures
Guidance for existing structures

• Many existing structures do not allow effective fish passage
• Removal should be first option & will ALWAYS have best result
• Replacement with fish friendlier design
• Remediate existing structure to improve connectivity
  • Ensure fit for purpose!
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Remove...

• Many structures are now redundant
• If it’s no longer needed, get rid of it!

• Example:
  • 30 year old decommissioned gauging weir on Great Barrier Island
  • Blocked access to 19 km of stream
  • Removed in summer & free access restored

Credit: Auckland Council
Replace...

- Is the structure:
  - In poor condition?
  - Near the end of its lifetime?
  - At risk of failing?
  - ...

- Consider replacement with new structure that meets minimum standards
Backwatering

Before

High water velocity

Drop

After

Raised water level
Ramps

• Fish ramps can be effective for overcoming drops
• Quite a bit of research done on ramp length, slope & substrate
• Simple summary:
  • Short = Good; Long = Bad
  • Gentle slope = Good; Steep = Bad
  • Roughened substrate = Good; Smooth substrate = Bad
Rock-ramp fishway

- Best practice to use rock-ramp fishways
- ‘Nature-like’ design
- Low slope (≤1:30)
- V-shaped cross-section
- Pools >2 m long
- Drop between pools <75 mm
Concrete rock-ramps

- Formal v informal designs
- V-shaped cross-section
- Low slope
  - Drop ≤0.5 m, slope ≤ 1:5
  - Drop ≤1.0 m, slope ≤ 1:10
  - Drop 1-4 m, slope ≤ 1:15
- Embedded rocks
- Resting pools
Plastic ramp

• New moulded plastic ramp
• Promising results under certain conditions
• Best results likely when:
  • All flow goes down ramp
  • Ramp isn’t full of water
  • Drop ≤0.5 m
• How does floating ramp impact success?
Baffles

• Culvert baffles can be effective where high water velocities limit fish passage
• Variety of designs proposed
• Spoiler baffle designs recommended option
• Weir type baffles not currently recommended
Fig. 3. Example of overhead images taken of a fish attempting to negotiate a circular culvert fitted with Alberta fish weir. A plan view of the experimental set up showing a typical path taken by fish during the test is also shown. Source: Feurich et al (2012)
Fig. 4. Example of overhead images taken of a fish negotiating a circular culvert fitted with spoiler baffles. A plan view of the experimental setup showing a typical path taken by fish during the test is also shown. Source: Feurich et al (2012)

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Mussel spat ropes

Mussel spat ropes can be cost-effective fix for SMALL culverts IF installed correctly

- Number of ropes scaled to culvert size
- Ropes tight and flush with culvert base
- Ropes full length of culvert
- ‘Swimming lanes’ between ropes for fish

- Too few ropes
- Ropes out of water!
- Ropes loose
- Ropes not full length of culvert
- Ropes old and worn
Tide gates

• Tide gates obstruct the movement of fish
• Gates close on incoming tide when most fish move upstream
• Automatic gates that only operate when required preferred option
• ‘Fish friendly’ self-regulating gates can be used to hold gates open for longer
Bypass structures

• Bypass structures
• Nature-like fishways
  • Mimic natural stream characteristics
• Technical fishways
  • Hard engineered designs
  • Vertical slot, denil, pool & weir
• Relatively few examples in NZ
Putting it in to practice
Putting it in to practice

• Solutions must be tailored to the site & target fish
• Promote best-practice & enforce minimum standards
• Aim high: minimise departure from unimpeded passage
• Not all ‘fixes’ are made equal
  • Some ‘off-the-shelf’ fixes aren’t good practice designs or have not been properly tested
  • Even a good fix won’t work if not installed correctly
Putting it in to practice

• Minimum design standards for new structures set out in Appendix G of the guidelines

• Intended for easy reference in regional planning framework

• Covers culverts, weirs & fords

• Difficult to specify similar minimum standards for remediation options

• BUT, Executive Summary does include list of recommended design parameters

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Appendix G  Minimum design standards for fish passage at instream structures

1. Minimum design standards for fish passage will achieve:

   a. Efficient and safe passage of all aquatic organisms and life stages with minimal delay, except where specific provisions are required to limit the movement of undesirable exotic species.
   b. A diversity of physical and hydraulic conditions leading to a high diversity of passage opportunities for aquatic species.
   c. A structure that will provide no greater impediment to fish movements than adjacent stream reaches.
   d. Structures that have minimal maintenance requirements and are durable.

2. Culverts installed in freshwater bodies will meet the following minimum design standards for fish passage:\n
   a. Alteration of natural stream channel alignment will be avoided or minimized.
   b. Alteration of natural stream gradient will be avoided or minimized.
   c. Culvert span will be:
      i. Equal to or greater than 1.3 x stream bankfull width for streams with a bankfull width ≤ 1 m.
      ii. Equal to or greater than 1.2 x stream bankfull width + 0.6 m for streams with a bankfull width > 1 m.
   d. Open bottom culverts will be used or the culvert invert will be embedded by 25-50% of culvert height.
   e. Well graded substrate will be present throughout the full length of the culvert bed.
   f. Substrate within the culvert will be stable at the high fish passage design flow.\n   g. Mean cross-sectional water velocity in the culvert over the fish passage design flow range will be equal to or less than the greater of:
      i. mean cross-sectional water velocity in adjacent stream reaches, or
      ii. the maximum allowable water velocity calculated from fish swimming speeds of agreed target fish species and/or life stages.\n   h. Minimum water depth in the culvert at the low fish passage design flow will be the lesser of:
      i. 150 mm for native fish passage, or 250 mm where adult salmonid passage is also required, or
      ii. mean cross-sectional depth in adjacent stream reaches.
   i. Ancillary structures must not create an impediment to fish passage.
   j. Vertical drops will be avoided throughout the structure.

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[1] Culvert span is defined as the width of the culvert at the point it intersects with the stream bed.
[2] Bankfull width is defined as the width of the main channel at the bankfull discharge. The bankfull discharge is the discharge that fills a static channel to the elevation of the active floodplain.
[3] See Section 4.2.2 for methodology and for look-up tables of maximum allowable water velocities.

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Putting in to practice

Some things to think about:

• Is this the right design for the situation?
• Is the design proven & well tested?
• Is the proven design being applied in a novel context?
• Is it a new/novel design?
• Has effectiveness of the new design been tested/proven?
• Does it have a good chance of working well?
Putting it in to practice

• Setting clear objectives is important
• Value of monitoring cannot be underestimated
• Pick a method suitable for your needs
  • Before-after-control-impact design
  • Mark-recapture
• Seek advice from experts if you need it!
Putting it in to practice

Regardless of method, critical to ensure data are collected in consistent, standardised and reproducible way:

• same method at each survey & site
• same sites are used each survey
• sampling effort is equivalent between reaches and surveys (i.e. the same area is fished)
• sampling is carried out under similar conditions (e.g. similar flows & same time of year)
Where can you find more information?

• Download the guidelines: www.niwa.co.nz/fishpassage
• Visit the DOC fish passage web pages: www.doc.govt.nz/fishpassage
• Sign up to the NZ Fish Passage Advisory Group mailing list
  Email: advisorygroup@fishpassagemnz.org
NZ Fish Passage Assessment Protocol

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NZ fish passage assessment tool

National fish passage assessment protocol tool due for release soon

• Objective
• Mobile application
• Web-tools
NZ fish passage assessment tool

- Standardised method for recording & assessing structures for fish passage
- Android & iOS versions
- Works for multiple structure types
- Links automatically to national database
NZ fish passage assessment tool webpage

- View & download data
- Determines risk to fish passage
- Calculates national statistics
  - Number of barriers in different risk classes
  - Proportion of the river network in different risk classes
- Calculates basic ecological prioritization scores for each structure
NZ fish passage assessment tool

- Scheduled for completion & sign-off in next few weeks
- Workshop planned for NZFSS conference
- Will be available to download from app stores
- Please use it for any fish passage assessments from now on!
Thank you

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Any questions?